DEPARTMENT OF THE ARMY
LOUISVILLE DISTRICT, CORPS OF ENGINEERS

CONTRACT NO: DACA27-88-C-0002

CAMPBELL DESIGN GROUP PROJECT NO.: 10-7578-01

FINAL SUBMITTAL

ENERGY SURVEY OF INDUSTRIAL FACILITIES (BLDGS. 208, 220 & 222)

ROCK ISLAND ARSENAL, ILLINOIS

EXECUTIVE SUMMARY

PREPARED BY:

CAMPBELL DESIGN GROUP
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JUNE, 1989

DEPARTMENT OF THE ARMY
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CHAPTER 1 - EXECUTIVE SUMMARY

1. Revised Summary of ECOs - Building 208 (Figure 1.5) as follows:

   a. Revised discounted savings, SIR and simple payback for auto. flue dampers at paint booths (ECO 2); project switched from "non-feasible" to "no govt. program."

   b. Revised discounted savings, SIR and simple payback for quick-opening doors at paint booths (ECO 13).

   c. Revised comment under "convert ovens to gas-fired" (ECO 21).

2. Revised Summary of ECOs - Building 220 (Figure 1.6) as follows:

   a. Deleted high-efficiency lamps and ballasts ECO.

   b. Revised total investment, SIR and simple payback for furnace heat recovery system (ECO 20).

   c. Revised comment under "convert ovens to gas-fired" (ECO 22).

3. Revised Summary of ECOs - Building 222 (Figure 1.7) as follows:

   a. Deleted high-efficiency lamps and ballasts ECO.

   b. Revised total investment, SIR and simple payback for furnace heat recovery system (ECO 11).

   c. Revised comment under "convert ovens to gas-fired" (ECO 30).

4. Revised Major ECOs Energy Savings chart (Figure 1.14) to identify savings in MBTU/yr.

CHAPTER 4 - FACILITY OPERATIONS

1. Revised Section 4.5, Description of Lighting Systems, as follows:

   a. Deleted reference to REARM-III lighting conversion from HPS to MH in Building 208.

   b. Revised high-bay lighting from MV to MH in Building 220.

2. Revised Building 220 - First Floor Lighting Layout (Figure 4.12) from MV to MH in the high-bay area.

CHAPTER 6 - SUMMARY OF ECOs

1. Added Section 6.1, "General," to describe summary matrices (Figures 6.1 through 6.3).

2. Added Section 6.2 to describe low cost/no cost projects included in summary matrices (Figures 6.1 through 6.3).

3. Revised Summary of ECOs (Figure 6.1 through 6.3) - Identical to revisions described above for Figures 1.5 through 1.7.

CHAPTER 7 - MAJOR ECOs

1. Deleted Section 7.3.22, High Efficiency Ballast/Lamp Replacement.

2. Deleted Section 7.4.5, High Efficiency Ballast/Lamp Replacement.

CHAPTER 8 - MAJOR ECO IMPLEMENTATION COST ESTIMATE

1. Revised estimate for furnace heat recovery (pages 8.49 and 8.103).

CHAPTER 9 - MAJOR ECO ENERGY SAVINGS CALCULATIONS

1. Revised Section 9.2.8, Install Dampers at Ceiling Exhaust Fans, to show correct infiltration rate of 405 FPM.

2. Revised energy savings calculations for Section 9.2.10, Automatic Flue Dampers at Paint Booths, to reflect savings during unoccupied/unutilized periods.

3. Revised energy savings calculations for Section 9.2.14, Separate Paint Areas with Quick Opening Doors, to factor in reduced cycle times.

4. Deleted Section 9.3.22, High-Efficiency Ballast/Lamp Replacement.

5. Deleted Section 9.4.15, High-Efficiency Ballast/Lamp Replacement.

CHAPTER 10 - MAJOR ECO ECONOMIC ANALYSIS

1. Revised electrical and coal energy costs in Section 10.1.2.

2. Revised LCCID for Building 208 - Paint Booth Flue Dampers.

3. Revised LCCID for Building 208 - Quick Opening Doors at Paint Area.

4. Revised LCCID for Building 220 - Furnace Heat Recovery.

5. Removed LCCID for Building 220 - High-Efficiency Ballasts/Lamps.

6. Revised LCCID for Building 222 - Furnace Heat Recovery.

7. Removed LCCID for Building 222 - High-Efficiency Ballasts/Lamps.

8. Revised DD Form 1391, adding Building 220, Lighting Control System, and deleting Building 220, High-Efficiency Lamps and Ballasts. Revisions are as follows:

   a. Block 9 - Change "High-Efficiency Lamps and Ballasts" to "Lighting Control System" and revised cost estimates accordingly.

   b. Block 10 - Revised Description of Proposed Construction.

   c. Block 11 - Revised Project, Requirement and Current Situation.

   d. Paragraph D3 - Analysis of Deficiency; Deleted High-Efficiency Lamps and Ballasts.

   e. Paragraph D4 - Consideration of Alternatives; Deleted High-Efficiency Lamps and Ballasts, and totalized alternatives.

   f. Paragraph D5 - Criteria for Proposed Lighting Control Systems; Deleted High-Efficiency Lamps and Ballasts.

   g. Paragraph D7 - Disposal of Present Assets; Deleted reference to High-Efficiency Lamps and Ballasts.

   h. Paragraph D11 - Economic Justification; Deleted High-Efficiency Lamps and Ballasts and added Lighting Control System (Building 220).

   i. Paragraph D15 - Energy Requirements; Deleted High-Efficiency Lamps and Ballasts and added Lighting Control System (Building 220).

   j. Paragraph D17 - Real Property Maintenance Activity (RPMA) Analysis; Deleted High-Efficiency Lamps and Ballasts and added Lighting Control System (Building 220).

   k. SRP.1 - Economic Analysis; Deleted High-Efficiency Lamps and Ballasts and added Lighting Control System (Building 220).

1. EXECUTIVE SUMMARY

1.1 INTRODUCTION

Campbell Design Group (CDG) has been retained by the Department of the Army, Louisville District, Corps of Engineers to conduct an Energy Study of Industrial Facilities at Rock Island Arsenal, Illinois. Specifically, CDG was contracted to survey Buildings 208, 220 and 222 of the Rock Island complex. This summary will highlight the contents of the Interim Submittal. Certain sections of this report are repeated to allow the narrative for each ECO to stand on its own.

It is our opinion that none of the recommended ECOs will have any impact upon mobilization should that occur. Should full mobilization occur during the construction/implementation of any of the ECOs a judgment will need to be made at that time whether to proceed or to back-off. We do, of course, strongly recommend that no construction/implementation of any ECO be started until all material parts and labor are on hand to quickly and efficiently complete the work.

1.2 BUILDING DATA

Buildings 208 and 220 have historical restrictions that preclude certain exterior modifications. Because of this we have analyzed these buildings so that where so affected, the recommended modifications will be internal rather than external. It should also be stated that in our opinion this has not reduced potential savings or restricted ECO's.

Although some of the renovations to the facilities scheduled for REARM Consolidate Manufacturing - Part III were not fully implemented at the time of the field surveys, the parameters used for energy calculations are "as-if" conditions based upon completion of REARM III.

1.3 PRESENT ENERGY CONSUMPTION

Since there is no energy consumption history available on an individual building basis, lighting, heating, ventilating and air conditioning (HVAC) energy usage are calculated on the basis of concurrent operation with scheduled occupancy, unless otherwise noted. Energy usage for production equipment is calculated at 20 percent of connected load for the 6:30 A.M. to 2:30 P.M. operating shift. Energy usage during other operating shifts is a weighted percentage of the 6:30 A.M.to 2:30 P.M. shift based on the reduced occupancy level. Since the production equipment is operated on a "job shop" basis, this provides only a rough approximation of expected energy usage in any given year of the study. It is strongly recommended that the arsenal facility meter each building and develop a history of energy consumption for reference purposes.

Calculated Total Annual Energy Used is tabulated for each building (Bldgs. 208, 220 & 222 - Figures 1.1 thru 1.3) individually and for all three (3) buildings combined (Figure 1.4). These tables are included at the end of this chapter. Electric KWH peak, electric KWH off-peak, electric KW peak, gas therm peak, and steam therm peak were all obtained from the Monthly Energy consumption - Alternate 1 BASE BUILDING summary on the first page of the applicable TRACE output for each building. Building MBTU (electric, natural gas, steam and total) were obtained by converting the furnished cost to government including losses (Rate "A", Memorandum SMCRI-EH) from nominal energy units (i.e. KWH, KCF and KLB) to MBTU. These conversions are as follows:

- Electricity: $0.0638/KWH x 2.928 x 10^2 KWH/MBTU
  = $18.60/MBTU

- Natural Gas: $4.99447/KCF/1.03 MBTU/KCF (Avg. Htg. Value)
  = $4.85/MBTU

- Steam: $3.6730/KLB/0.924 MBTU/KLB (40 psig steam)
  = $3.98/MBTU

A portion of the electrical energy required for RIA is generated by a hydro electrical plant. Capacity 2800 KW which is owned and operated by RIA. The remainder of RIA electrical needs are purchased from Iowa, Illinois Gas Co.

Applicable rate structures for electricity and natural gas were obtained from Erik C. Madsen, Senior Rate Specialist with Iowa-Illinois Gas and Electric Company. These schedules are included in Appendix 11.3. Rates were escalated through the life of the study (25 years) utilizing the Projected Average Fuel Price Indices tabulated in NBS Handbook 135 for the purpose of life-cycle cost analysis.

The three (3) buildings in this study are part of base-wide electrical, gas and steam distribution systems. At the present time, there is no submetering of energy usage at the individual buildings. Therefore, it is not possible to assemble historical energy consumption data for the facilities under evaluation. In addition, given the diverse operations of the many buildings that make up the Rock Island Arsenal complex, it was ascertained that weighting energy usage of the three (3) buildings in this study based on the available facility consumption would provide meaningless data. For these reasons it is strongly recommended that the facility meter each building and develop an energy usage history that will allow for direct comparison of future conservation measures.

1.4 ENERGY CONSERVATION ANALYSIS

A Summary of Energy Conservation Opportunities (ECOs) investigated for this project are tabulated by building at the end of this chapter (Figs, 1.5 thru 1.7). ECOs are designated as ECIP or Non-ECIP. Non-ECIP projects are further categorized as Quick Return on Investment Program (QRIP), OSD Productivity Investment Funding (OSD PIF), Productivity Enhancing Capital Investment Funding (PECIP), Military Construction Army (MCA) Program, Low Cost/No Cost Projects, Operational/Maintenance & Procedure (OM&P) Projects and Non-Feasible ECOs. Reasons and/or justifications for rejecting Non-Feasible ECOs are listed in the "Comments" column. These programs are graphically summarized in Figure 1.8 at the end of this chapter.

These ECOs are based on site conditions during the field surveys conducted during the weeks of January 25 and March 7, 1988, and modifications to the facilities scheduled for implementation during the REARM-III renovation project. ECOs that were identified for further study during the Exit Interview are described in greater detail with design assumptions made for cost estimating, energy requirements and economic analysis.

Preliminary cost estimates for each of the ECOs chosen for further evaluation are tabulated by building in Figs, 1.5 thru 1.7. These are order of magnitude estimates exclusive of engineering costs, and are not intended to be construction estimates. Costs were estimated using 1988 labor and material costs, generally as published by Means.

1.5 ENERGY AND COST SAVINGS

Energy savings for each of the selected ECOs are tabulated by building in Figs, 1.5 thru 1.7. Energy consumption for major architectural and electrical ECOs were computed using the TRACE Energy Simulation Program. Energy savings for minor facility ECOs and production/process ECOs are computed manually using accepted engineering techniques.

Key economic criteria (SIR, Simple Payback) of each of the selected ECOs is tabulated by building in Figs, 1.5 thru 1.7. In certain cases, combinations of ECO's are analyzed. The Life Cycle Cost in Design program (LCCID) was used for performing the life-cycle cost analysis. This program is certified for use on D.O.D. construction and produces results identical to the CDS Government Economics Plan. Each alternate is compared to the baseline system (Alt. 1) by generating a Savings to Investment Ratio (SIR) and a Discounted Payback Period (DPP). Also included in this chapter is one complete ECIP project using standard programming documentation (DD Form 1391, PDB and supporting data).

1.6 ENERGY PLAN

It is beyond the scope of this Interim Submittal to delineate a detailed energy plan for the Rock Island Arsenal complex. Rather, it is the intent to provide a "shopping list" of alternates to be compared and evaluated as to their economies and practicality. Although a purely objective ranking of ECOs is possible at this time, there are judgmental criteria which must be taken into consideration. These include Rock Island Arsenal operating parameters which were not readily apparent during the field surveys and long-term strategies being developed and/or pursued by the U.S. Corps of Engineers.

When these factors are given due consideration, a detailed energy plan with project breakouts, total costs and SIRs will be prepared for inclusion in the Final Report. Also to be included in this submittal will be a Schedule of Energy Conservation Project Implementation.

(1)

TOTAL ANNUAL ENERGY USED - BUILDING 208

MONTH	ELEC. KWH PEAK	ELEC. KWH OFFPEAK	KW PEAK	GAS THERM PEAK	STEAM THERM PEAK	BLDG. MBTU (ELEC)	B (
JAN	363,947	321,848	1,944	968	34,260	2,340,618	
FEB	346,966	306,492	1,944	922	34,537	2,230,252	
MAR	387,373	346,745	1,940	1,060	24,992	2,505,545	
APR	330,052	289,369	1,927	922	5,621	2,114,084	
MAY	381,511	306,645	2,018	1,014	118	2,348,676	
JUN	332,226	315,679	2,018	1,014	0	2,416,080	
JUL	358,000	310,217	2,018	922	0	2,280,625	
AUG	409,915	330,496	2,018	1,060	0	2,527,019	
SEP	348,404	277,835	2,018	922	0	2,137,354	
OCT	347,436	315,406	1,912	1,014	4,678	2,252,280	
NOV	347,814	308,627	1,934	968	12,840	2,240,433	
DEC	356,937	306,747	1,943	922	39,313	2,265,153	
TOTAL	4,370,581	3,736,105	2,018	11,708	156,359	27,668,119	

TOTAL ANNUAL ENERGY USED - BUILDING 220

MONTH	ELEC. KWH PEAK	ELEC. KWH OFFPEAK	KW PEAK	GAS THERM PEAK	STEAM THERM PEAK	BLDG. MBTU (ELEC)	BI ((
JAN	589,961	454,419	3,773	16,065	81,126	3,564,469	
FEB	549,817	431,971	3,773	15,300	65,047	3,350,842	
MAR	619,173	493,118	3,755	17,595	52,513	3,796,249	
APR	543,815	420,150	3,747	15,300	16,783	3,290,013	
MAY	584,341	449,120	3,742	16,830	2,404	3,527,202	
JUN	583,140	450,852	3,753	16,830	935	3,529,015	
JUL	549,432	413,723	3,769	15,300	850	3,287,248	
AUG	606,411	470,067	3,748	17,595	977	3,674,019	
SEP	531,184	409,768	3,736	15,300	1,569	3,211,469	
OCT	582,591	462,954	3,735	16,830	17,339	3,568,445	
NOV	570,126	446,797	3,751	16,065	38,106	3,470,758	
DEC	570,464	433,710	3,772	15,300	83,203	3,427,246	
TOTAL	6,880,455	5,336,649	3,773	194,310	360,852	41,696,976	1

Notes:

1. Total energy consumption was estimated using the TRACE Energy

2. Electric peak demand (KW) is included in these tabulations since it is

(2)

TEAM HERM BAK	BLDG. MBTU (ELEC)	BLDG. MBTU (GAS)	BLDG. MBTU (STEAM)	BLDG. MBTU (TOTAL)	BLDG. $ (ELEC)	BLDG. $ (GAS)	BLDG. $ (STEAM)	BLDG. $ (TOTAL)
34,260	2,340,618	96,800	3,426,000	5,863,418	$34,310	$331	$11,347	$45,988
34,537	2,230,252	92,200	3,453,700	5,776,152	$33,503	$315	$11,439	$45,257
24,992	2,505,545	106,000	2,499,200	5,110,745	$35,473	$362	$8,277	$44,112
5,621	2,114,084	92,200	562,100	2,768,384	$32,565	$315	$1,862	$34,742
118	2,348,676	101,400	11,800	2,461,876	$34,967	$345	$39	$35,352
0	2,416,080	101,400	0	2,517,480	$44,237	$346	$0	$44,583
0	2,280,625	92,200	0	2,372,825	$42,970	$315	$0	$43,285
0	2,527,019	106,000	0	2,633,019	$45,125	$362	$0	$45,487
0	2,137,354	92,200	0	2,229,554	$42,013	$315	$0	$42,328
4,678	2,252,280	101,400	467,800	2,831,480	$33,506	$346	$1,549	$35,402
12,840	2,240,433	96,800	1,284,000	3,621,233	$33,512	$331	$4,253	$38,096
39,313	2,265,153	92,200	3,931,300	6,288,653	$33,801	$315	$13,020	$47,136
156,359	27,668,119	1,170,800	15,635,900	44,474,819	$445,982	$3,993	$51,786	$501,768

TEAM HERM BAK	BLDG. MBTU (ELEC)	BLDG. MBTU (GAS)	BLDG. MBTU (STEAM)	BLDG. MBTU (TOTAL)	BLDG. $ (ELEC)	BLDG. $ (GAS)	BLDG. $ (STEAM)	BLDG. $ (TOTAL)
81,126	3,564,469	1,606,500	8,112,600	13,283,569	$54,225	$5,410	$26,869	$86,504
65,047	3,350,842	1,530,000	6,504,700	11,385,542	$52,587	$5,153	$21,544	$79,283
52,513	3,796,249	1,759,500	5,251,300	10,807,049	$55,749	$5,925	$17,392	$79,066
16,783	3,290,013	1,530,000	1,678,300	6,498,313	$52,027	$5,153	$5,559	$62,738
2,404	3,527,202	1,683,000	240,400	5,450,602	$53,774	$5,668	$796	$60,238
935	3,529,015	1,683,000	93,500	5,305,515	$69,567	$5,668	$310	$75,544
850	3,287,248	1,530,000	85,000	4,902,248	$67,849	$5,153	$282	$73,284
977	3,674,019	1,759,500	97,700	5,531,219	$70,683	$5,925	$324	$76,932
1,569	3,211,469	1,530,000	156,900	4,898,369	$66,845	$5,153	$520	$72,518
17,339	3,568,445	1,683,000	1,733,900	6,985,345	$53,951	$5,668	$5,743	$65,362
38,106	3,470,758	1,606,500	3,810,600	8,887,858	$53,356	$5,410	$12,621	$71,387
83,203	3,427,246	1,530,000	8,320,300	13,277,546	$53,232	$5,153	$27,557	$85,942
360,852	41,696,976	19,431,000	36,085,200	97,213,176	$703,846	$65,439	$119,514	$888,800

using the TRACE Energy Simulation Program.

ulations since it is a component of the utility rate structure.

BLDG. MBTU (TOTAL)	BLDG. $ (ELEC)	BLDG. $ (GAS)	BLDG. $ (STEAM)	BLDG. $ (TOTAL)
5,863,418	$34,310	$331	$11,347	$45,988
5,776,152	$33,503	$315	$11,439	$45,257
5,110,745	$35,473	$361	$8,277	$44,112
2,768,384	$32,565	$315	$1,862	$34,742
2,461,876	$34,967	$346	$39	$35,352
2,517,480	$44,237	$346	$0	$44,583
2,372,825	$42,970	$315	$0	$43,285
2,633,019	$45,125	$362	$0	$45,487
2,229,554	$42,013	$315	$0	$42,328
2,831,480	$33,506	$346	$1,549	$35,402
3,621,233	$33,512	$331	$4,253	$38,096
6,288,653	$33,801	$315	$13,020	$47,136
44,474,819	$445,982	$3,993	$51,786	$501,768

BLDG. MBTU (TOTAL)	BLDG. $ (ELEC)	BLDG. $ (GAS)	BLDG. $ (STEAM)	BLDG. $ (TOTAL)
13,283,569	$54,225	$5,410	$26,869	$86,504
11,385,542	$52,587	$5,153	$21,544	$79,283
10,807,049	$55,749	$5,925	$17,392	$79,066
6,498,313	$52,027	$5,153	$5,559	$62,738
5,450,602	$53,774	$5,668	$796	$60,238
5,305,515	$69,567	$5,668	$310	$75,544
4,902,248	$67,849	$5,153	$282	$73,284
5,531,219	$70,683	$5,925	$324	$76,932
4,898,369	$66,845	$5,153	$520	$72,518
6,985,345	$53,951	$5,668	$5,743	$65,362
8,887,858	$53,356	$5,410	$12,621	$71,387
13,277,546	$53,232	$5,153	$27,557	$85,942
97,213,176	$703,846	$65,439	$119,514	$888,800

ity rate structure.

FIGURE 1.1

FIGURE 1.2

TOTAL ENERGY CONSUMPTION - BUILDING 222

MONTH	ELEC. KWH PEAK	ELEC. KWH OFFPEAK	KW PEAK	GAS THERM PEAK	STEAM THERM PEAK	BLDG. MBTU (ELEC)	B (
JAN	136,682	90,859	980	7,268	15,152	776,597	
FEB	128,782	86,159	979	6,922	13,646	733,594	
MAR	147,041	97,274	979	7,960	15,011	833,847	
APR	126,680	82,738	959	6,922	12,165	714,744	
MAY	136,271	90,453	959	7,614	13,076	773,809	
JUN	136,079	90,392	959	7,614	13,076	772,946	
JUL	124,424	81,951	956	6,922	11,888	704,358	
AUG	142,195	94,500	959	7,960	13,671	807,840	
SEP	124,344	82,231	959	6,922	11,888	705,040	
OCT	137,012	90,453	959	7,614	13,076	776,338	
NOV	134,516	87,311	959	7,268	13,011	757,096	
DEC	131,333	86,189	979	6,922	14,044	742,403	
TOTAL	1,605,359	1,060,510	980	87,908	159,704	9,098,611	

TOTAL ANNUAL ENERGY USED - BUILDINGS 208, 220 & 222

MONTH	ELEC. KWH PEAK	ELEC. KWH OFFPEAK	KW PEAK	GAS THERM PEAK	STEAM THERM PEAK	BLDG. MBTU (ELEC)	B (
JAN	1,090,590	867,126	6,697	24,301	130,538	6,681,685	
FEB	1,025,565	824,622	6,696	23,144	113,230	6,314,688	
MAR	1,153,587	937,137	6,674	26,615	92,516	7,135,641	
APR	1,000,547	792,257	6,633	23,144	34,569	6,118,840	
MAY	1,102,123	846,218	6,719	25,458	15,598	6,649,688	
JUN	1,111,445	856,923	6,730	25,458	14,011	6,718,040	
JUL	1,031,856	805,891	6,743	23,144	12,738	6,272,231	
AUG	1,158,521	895,062	6,725	26,615	14,648	7,008,879	
SEP	1,003,932	769,834	6,713	23,144	13,457	6,053,863	
OCT	1,067,039	868,813	6,606	25,458	35,093	6,607,063	
NOV	1,052,456	842,735	6,644	24,301	63,957	6,468,287	
DEC	1,058,734	826,646	6,694	23,144	136,560	6,434,802	
TOTAL	12,856,395	10,133,264	6,743	293,926	676,915	78,463,706	

Notes:

1. Total energy consumption was estimated using the TRACE Ener

2. Electric peak demand (KW) is included in these tabulations since it is

BLDG. MBTU (ELEC)	BLDG. MBTU (GAS)	BLDG. MBTU (STEAM)	BLDG. MBTU (TOTAL)	BLDG. $ (ELEC)	BLDG. $ (GAS)	BLDG. $ (STEAM)	BLDG. $ (TOTAL)
776,597	726,800	1,515,200	3,018,597	$17,439	$2,450	$5,018	$24,908
733,594	692,200	1,364,600	2,790,394	$17,105	$2,334	$4,520	$23,959
833,847	796,000	1,501,100	3,130,947	$17,868	$2,683	$4,972	$25,523
714,744	692,200	1,216,500	2,623,444	$16,860	$2,334	$4,029	$23,223
773,809	761,400	1,307,600	2,842,809	$17,297	$2,567	$4,331	$24,195
772,946	761,400	1,307,600	2,841,946	$21,258	$2,567	$4,331	$28,156
704,358	692,200	1,188,800	2,585,358	$20,671	$2,334	$3,937	$26,942
807,840	796,000	1,367,100	2,970,940	$21,546	$2,683	$4,528	$28,757
705,040	692,200	1,188,800	2,586,040	$20,701	$2,334	$3,937	$26,973
776,338	761,400	1,307,600	2,845,338	$17,320	$2,567	$4,331	$24,217
757,096	726,800	1,301,100	2,784,996	$17,184	$2,450	$4,309	$23,943
742,403	692,200	1,404,400	2,839,003	$17,182	$2,334	$4,651	$24,168
9,098,611	8,790,800	15,970,400	33,859,811	$222,431	$29,638	$52,894	$304,964

BLDG. MBTU (ELEC)	BLDG. MBTU (GAS)	BLDG. MBTU (STEAM)	BLDG. MBTU (TOTAL)	BLDG. $ (ELEC)	BLDG. $ (GAS)	BLDG. $ (STEAM)	BLDG. $ (TOTAL)
6,681,685	2,430,100	13,053,800	22,165,585	105,974	8,192	43,234	157,400
6,314,688	2,314,400	11,323,000	19,952,088	103,195	7,802	37,502	148,499
7,135,641	2,661,500	9,251,600	19,048,741	109,090	8,970	30,641	148,702
6,118,840	2,314,400	3,456,900	11,890,140	101,452	7,802	11,449	120,704
6,649,688	2,545,800	1,559,800	10,755,288	106,039	8,581	5,166	119,785
6,718,040	2,545,800	1,401,100	10,664,940	135,061	8,581	4,640	148,283
6,272,231	2,314,400	1,273,800	9,860,431	131,490	7,802	4,219	143,511
7,008,879	2,661,500	1,464,800	11,135,179	137,354	8,970	4,851	151,176
6,053,863	2,314,400	1,345,700	9,713,963	129,560	7,802	4,457	141,819
6,607,063	2,545,800	3,509,300	12,662,163	104,777	8,581	11,623	124,981
6,468,287	2,430,100	6,395,700	15,294,087	104,052	8,192	21,183	133,426
6,434,802	2,314,400	13,656,000	22,405,202	104,215	7,802	45,229	157,246
78,463,706	29,392,600	67,691,500	175,547,806	$1,372,260	$99,077	$224,194	$1,695,531

he TRACE Energy Simulation Program.

s since it is a component of the utility rate structure.

3

LDG. $ ELEC)	BLDG. $ (GAS)	BLDG. $ (STEAM)	BLDG. $ (TOTAL)
$17,439	$2,450	$5,018	$24,908
$17,105	$2,334	$4,520	$23,959
$17,868	$2,683	$4,972	$25,523
$16,860	$2,334	$4,029	$23,223
$17,297	$2,567	$4,331	$24,195
$21,258	$2,567	$4,331	$28,156
$20,671	$2,334	$3,937	$26,942
$21,546	$2,683	$4,528	$28,757
$20,701	$2,334	$3,937	$26,973
$17,320	$2,567	$4,331	$24,217
$17,184	$2,450	$4,309	$23,943
$17,182	$2,334	$4,651	$24,168
$222,431	$29,638	$52,894	$304,964

LDG. $ ELEC)	BLDG. $ (GAS)	BLDG. $ (STEAM)	BLDG. $ (TOTAL)
105,974	8,192	43,234	157,400
103,195	7,802	37,502	148,499
109,090	8,970	30,641	148,702
101,452	7,802	11,449	120,704
106,039	8,581	5,166	119,785
135,061	8,581	4,640	148,283
131,490	7,802	4,219	143,511
137,354	8,970	4,851	151,176
129,560	7,802	4,457	141,819
104,777	8,581	11,623	124,981
104,052	8,192	21,183	133,426
104,215	7,802	45,229	157,246
$1,372,260	$99,077	$224,194	$1,695,531

cture.

FIGURE 1.3
FIGURE 1.4

SUMMARY OF ENERGY CONSERVATION OPPORTUNITIES (ECOs)
BUILDING 208 - HEAVY GUN PLANT

NO. ECO	DESCRIPTION	DETAILED DESCRIP.	INVESTMENT COST	DISCOUNTED SAVINGS	DISCOUNTED COSTS
1	INSTALL DAMPERS AT CEILING EXHAUST FANS	7.2.8	$8,910	$514,891	$70,296
2	INSTALL AUTO. FLUE DAMPERS AT PAINT BOOTHS	7.2.10	$5,842	$50,969	$23,428
3	RE-CAULK/WEATHERSTRIP EXTERIOR DOORS	7.2.11	$395	$1,851	$0
4	LIGHTING CONTROL SYSTEM	7.2.3	$57,832	$223,977	$10,462
5	INSTALL CEILING CIRCULATING FANS	7.2.7	$35,167	$116,975	$0
6	REPAIR/REPLACE OVERHEAD DOOR SEALS	7.2.1	$10,192	$16,046	$0
7	INSTALL AIR CURTAINS AT OVERHEAD DOORS	7.2.2	$27,534	$25,850	$10,660
8	INSTALL HIGH-EFFICIENCY MOTORS ON ALL EQUIP.	7.2.15	$114,814	$57,576	$0
9	INSTALL QUICK-OPENING DOORS AT EXT. O.H. DOORS	7.2.6	$64,847	$27,576	$10,660
10	INSTALL STEAM COILS IN HYDRAULIC RESERVOIRS	7.2.12	$71,089	$59,919	$45,575
11	INSULATE INSIDE OF GLASS BLOCK WINDOWS	7.2.4	$105,852	$13,145	$0
12	INSULATE INSIDE OF EXTERIOR WALLS	7.2.5	$336,180	$11,179	$0
13	SEPERATE PAINT AREAS W/QUICK-OPENING DOORS	7.2.14	$51,138	$789	$6,396
14	RECLAIM HEAT FROM PROCESS EXHAUST AIR	--	$1,066,000	--	--
15	CLEAN & LUBRICATE MOTORS	--	--	--	--
16	INSTALL POWER FACTOR CORRECTION EQUIPMENT	--	--	--	--
17	INSTALL DP CONTROLS AT ALL FILTER BANKS	--	--	--	--
18	SCHEDULE JANITORIAL WORK DURING OPERATING HRS.	--	--	--	--
19	INSTITUTE PREVENTATIVE MAINTENANCE PROGRAM	--	--	--	--
20	RESCHEDULE PRODUCTION TO OFF-PEAK HOURS	7.2.9	--	--	--
21	CONVERT ELECTRIC OVENS TO GAS-FIRED	--	--	--	--
22	REPAIR HOSES ON COMPRESSED AIR SYSTEM	--	--	--	--
23	INSTALL GENERATOR SET TO REDUCE PEAK KW	7.2.13	--	--	--
24	CONTROL LIGHTS W/MOTION OR HEAT DETECTORS	--	--	--	--
25	FILTER & RECIRCULATE PROCESS EXHAUST AIR	--	$294,000	--	--

DISCOUNTED SAVINGS	DISCOUNTED COSTS	SIR	SIMPLE PAYBACK	ECIP	QRIP	PECIP OSD PIF	MCA	LOW COST NO COST	NO GOVT. PROGRAM	NON-FEASIBLE
$514,891	$70,296	49.90	0.27		0					
$50,969	$23,428	4.71	3.17						0	
$1,851	$0	4.69	0.89		0					
$223,977	$10,462	3.69	2.68						0	
$116,975	$0	3.33	4.10						0	
$16,046	$0	1.57	4.73						0	
$25,850	$10,660	0.55	26.47							0
$57,576	$0	0.50	19.88						0	
$27,576	$10,660	0.26	55.38							0
$59,919	$45,575	0.20	27.80						0	
$13,145	$0	0.12	106.45							0
$11,179	$0	0.03	397.57							0
$789	$6,396	-0.11	******							0
--	--	--	--							0
--	--	--	--					0		
--	--	--	--							0
--	--	--	--					0		
--	--	--	--					0		
--	--	--	--							
--	--	--	--							0
--	--	--	--					0		
--	--	--	--							0
--	--	--	--							0
--	--	--	--							0

LOW COST NO COST	NO GOVT. PROGRAM	NON-FEASIBLE	COMMENTS
	0		Doesn't meet the criteria of any established government program.
	0		Doesn't meet the criteria of any established government program.
	0		Doesn't meet the criteria of any established government program.
	0		Doesn't meet the criteria of any established government program.
		0	Simple payback period exceeds 25 years.
	0		Doesn't meet the criteria of any established government program.
		0	Simple payback period exceeds 25 years.
	0		Doesn't meet the criteria of any established government program.
		0	Simple payback period exceeds 25 years.
		0	Simple payback period exceeds 25 years.
		0	Simple payback period exceeds 25 years.
		0	Temperature of exhaust air too low for efficient heat transfer.
0			
		0	Automatically controlled capacitor banks already installed.
0			
0			
0			
			No capital expenditure; possible increase in labor costs.
		0	(See Note 1 - Figure 1.7)
0			
		0	No quantifiable energy savings.
		0	Unacceptable time-lag with MH and HPS light fixtures.
		0	Not feasible due to toxicity of exhaust fumes.

FIGURE 1.5

SUMMARY OF ENERGY CONSERVATION OPPORTUNITIES (ECOs)
BUILDING 208 - HEAVY GUN PLANT (CONT'D.)

NO. ECO	DESCRIPTION	DETAILED DESCRIP.	INVESTMENT COST	DISCOUNTED SAVINGS	DISCOUNTED COSTS	SIR	SIMPLE PAYBACK	ECIF	SRIP	FEDIP OSD PIF	MCA	LOW CO NO CO
26	CHARGE ALL BATTERIES DURING OFF-PEAK HOURS	--	--	--	--		-					
27	KEEP O.H. DOORS CLOSED DURING HEATING SEASON	--	--	--	--	--	-					
28	INTERLOCK HYDRAULIC POWER PACK W/ASSOC. EQUIP.	--	$1,000	--	--	--	--					
29	PROVIDE ZONE CONTROL OF HVAC SYSTEM(S)	--	--	--	--	--	--					
30	REVERSE OPERATION OF EXHAUST FANS IN SUMMER	--	--	--	--	--	--					
31	INTERLOCK DEGREASER PIT EXHAUST FAN W/PROCESS	--	--	--	--	--	--					
32	INSTALL INTEGRATED MAKE-UP AIR SYSTEM	--	$377,000	--	--	--	--					

(2)

SIMPLE PAYBACK	ECIP	GSIP	PSCIP OSD PIP	MCA	LOW COST NO COST	NO GOVT PROGRAM	NON FEASIBLE	COMMENTS
--							0	
--					0			
--							0	Energy savings at idling speed not sufficient to offset cost.
--					.		0	Req'd. duct modifications too extensive to be cost effective.
--							0	Not a true ECO; no associated energy savings.
--							0	Exhaust fan and process already cycled together.
--							0	Req'd. duct modifications too extensive to be cost effective.

FIGURE 1.5 (CONT'D)

SUMMARY OF ENERGY CONSERVATION OPPORTUNITIES (ECOs)
BUILDING 220 - MACHINE SHOP

ECO NO.	DESCRIPTION	DETAILED DESCRIP.	TOTAL INVESTMENT	DISCOUNTED SAVINGS	DISCOUNTED COST	SIR	SIMPLE PAYBACK	ECIP	QRIP
1	INSTALL CEILING CIRCULATING FANS	7.3.11	$10,074	$185,258	$0	18.39	0.72		0
2	INTERLOCK NORTH O.H. DOORS AT STEEL ROOM	7.3.9	$995	$5,988	$1,072	4.94	2.76		
3	RE-CAULK/WEATHERSTRIP EXTERIOR DOORS	7.3.18	$3,640	$17,128	$0	4.71	0.89		0
4	REPAIR/REPLACE O.H. DOOR SEALS	7.3.1	$12,074	$17,056	$0	1.41	5.27		
5	LIGHTING CONTROL SYSTEM	7.3.5	$138,830	$190,716	$10,462	1.30	7.62		
6	INSTALL PLEXIGLAS STORM WINDOWS	7.3.7	$761,789	$618,575	$0	0.81	16.28		
7	INSTALL PLASTIC BARRIER AT UPPER LVL BALCONIES	7.3.4	$138,177	$101,632	$0	0.74	17.97		
8	INSTALL HIGH-EFFICIENCY MOTORS ON ALL EQUIP.	7.3.21	$422,131	$223,537	$0	0.53	18.83		
9	MODIFY EXISTING WINDOWS	7.3.6	$1,520,142	$705,049	$0	0.46	28.50		
10	INSTALL AIR CURTAIN/HEATER AT O.H. DOORS	7.3.2	$28,119	$25,850	$12,792	0.46	32.80		
11	APPLY CERAMIC COATING TO FURNACE REFRACTORY	7.3.15	$99,347	$28,940	$0	0.29	72.95		
12	INSTALL QUICK-OPENING DOORS AT ALL O.H. DOORS	7.3.10	$116,382	$32,985	$10,660	0.19	73.66		
13	INSTALL REGENERATIVE BURNERS ON FURNACES	7.3.13	$266,647	$33,289	$4,800	0.11	230.95		
14	INSTALL STEAM COILS IN HYDRAULIC RESERVOIRS	7.3.19	$177,720	$59,919	$45,575	0.08	69.50		
15	INSTALL SEALS ON FURNACE DOORS	7.3.12	$36,262	$2,855	$0	0.08	269.92		
16	INSTALL RECUPERATIVE BURNERS ON FURNACES	7.3.14	$250,752	$25,601	$4,800	0.08	316.31		
17	INSULATE INSIDE OF EXTERIOR WALLS	7.3.8	$626,488	$46,809	$0	0.07	176.93		
18	INSTALL AIR CURTAINS AT UPPER LEVEL BALCONIES	7.3.3	$584,713	$76,224	$187,612	-0.19	-56.56		
19	INSTALL FURNACE HEAT RECOVERY SYSTEM	7.3.16	$218,196	$34,670	$104,489	-0.32	-29.47		
20	SCHEDULE PRODUCTION TO MINIMIZE REHEATING	--	--	--	--	--	--		
21	CONVERT ELECTRIC OVENS TO GAS-FIRED	--	--	--	--	--	--		
22	CALIBRATE FURNACE CONTROLLERS & THERMOCOUPLES	--	--	--	--	--	--		
23	RESCHEDULE PRODUCTION TO OFF-PEAK HOURS	7.3.17	--	--	--	--	--		
24	KEEP O.H. DOORS CLOSED DURING HEATING SEASON	--	--	--	--	--	--		
25	INSTALL GENERATOR SET TO REDUCE PEAK KW	7.3.20	--	--	--	--	--		

SIMPLE PAYBACK	EEIP	QRIP	PECIP OSD PIP	MCA	LOW COST NO COST	NO GOVT. PROGRAM	NON-FEASIBLE	COMMENTS
0.72		0						
2.76						0		Doesn't meet criteria of any established government program.
0.89		0						
5.27						0		Doesn't meet criteria of any established government program.
7.62						0		Doesn t meet criteria of any established government program.
16.28				0				
17.97						0		Doesn't meet criteria of any established government program.
18.83				0				
28.50							0	Simple payback exceeds 25 years.
32.80							0	Simple payback exceeds 25 years.
72.95							0	Simple payback exceeds 25 years.
73.66							0	Simple payback exceeds 25 years.
230.95							0	Simple payback exceeds 25 years.
69.50							0	Simple payback exceeds 25 years.
269.92							0	Simple payback exceeds 25 years.
316.31							0	Simple payback exceeds 25 years.
176.93							0	Simple payback exceeds 25 years.
-56.56							0	Simple payback exceeds 25 years.
-29.47							0	Simple payback exceeds 25 years.
--					0			
--							0	(See Note 1 - Figure 1.7)
--					0			
--					0			No capital expenditure; possible increase in labor costs.
--					0			
--							0	No quantifiable energy savings.

FIGURE 1.6

SUMMARY OF ENERGY CONSERVATION OPPORTUNITIES (ECOs)
BUILDING 220 - MACHINE SHOP

ECO NO.	DESCRIPTION	DETAILED DESCRIP.	TOTAL INVESTMENT	DISCOUNTED SAVINGS	DISCOUNTED COST	SIR	SIMPLE PAYBACK	ECIP	ORIP
26	REPAIR HOSES ON COMPRESSED AIR SYSTEM	--	--	--	--	--	--		
27	CHARGE ALL BATTERIES DURING OFF-PEAK HOURS	--	--	--	--	--	--		
28	INSTALL POWER FACTOR CORRECTION EQUIPMENT	--	--	--	--	--	--		
29	CLEAN & LUBRICATE MOTORS	--	--	--	--	--	--		
30	CONTROL LIGHTS W/MOTION OR HEAT DETECTORS	--	--	--	--	--	--		
31	INSTITUTE PREVENTATIVE MAINTENANCE PROGRAM	--	--	--	--	--	--		
32	CHECK & REPLACE DEFECTIVE STEAM TRAPS	--	--	--	--	--	--		
33	SCHEDULE JANITORIAL WORK DURING OPERATING HRS.	--	--	--	--	--	--		

SIMPLE PAYBACK	ECIP	QRIP	ECIP O&M PIP	MCA	LOW COST/ NO COST	NO GOVT. PROGRAM	NON-FEASIBLE	COMMENTS
--					0			
--							0	Prohibited by cool-down requirement.
--							0	Automatically controlled capacitor banks already installed.
--					0			
--							0	Unacceptable time-lag with MH and HPS light fixtures.
--					0			
--					0			
--					0			

FIGURE 1.6 (CONT'D)

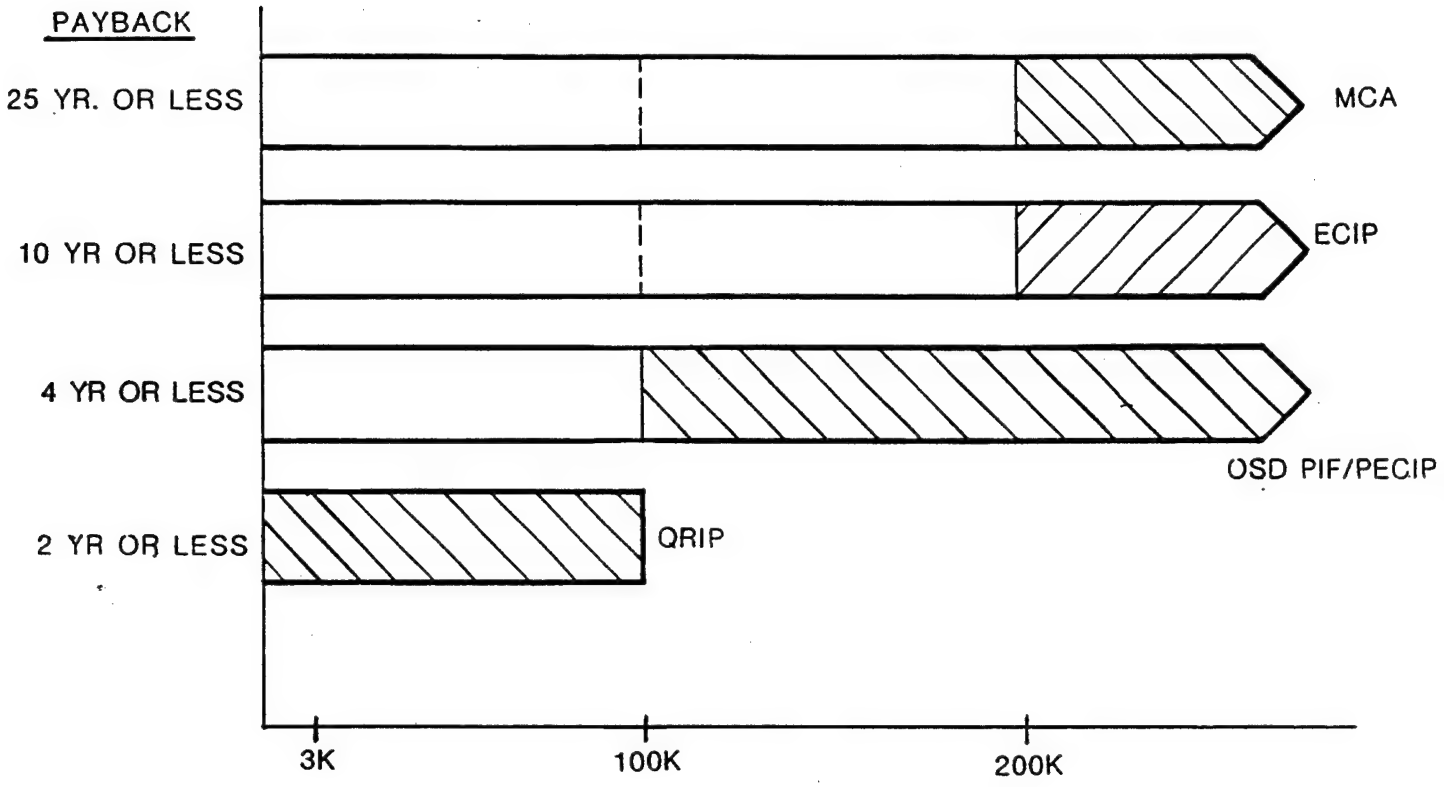
SUMMARY OF ENERGY CONSERVATION OPPORTUNITIES (ECOs)
BUILDING 222 - FORGE SHOP

ECO NO.	DESCRIPTION	DETAILED DESCRIP.	TOTAL INVESTMENT	DISCOUNTED SAVINGS	DISCOUNTED COSTS	SIR	SIMPLE PAYBACK	ECIP	GRIP	PECIP (OSD PIP)	MCA	LOW COST/N NO COST
1	INSTALL CEILING CIRCULATING FANS	7.4.9	$19,761	$194,886	$0	9.86	1.35		0			
2	APPLY CERAMIC COATING TO FURNACE REFRACTORY	7.4.19	$69,242	$173,640	$0	2.51	8.47					
3	RE-CAULK/WEATHERSTRIP EXTERIOR DOORS	7.4.11	$196	$474	$0	2.39	1.75		0			
4	LIGHTING CONTROL SYSTEM	7.4.3	$22,173	$61,405	$10,462	2.30	4.21					
5	REPAIR/REPLACE OVERHEAD DOOR SEALS	7.4.1	$3,885	$4,874	$0	1.25	5.93					
6	INSULATE SKYLIGHTS	7.4.4	$45,914	$53,019	$0	1.15	11.45					
7	INSTALL RECUPERATIVE BURNERS ON FURNACES	7.4.18	$281,984	$222,368	$3,728	0.78	27.80					
8	INSTALL AIR CURTAINS AT OVERHEAD DOORS	7.4.2	$8,699	$9,976	$4,264	0.66	22.38					
9	INSTALL PLEXIGLAS STORM WINDOWS	7.4.6	$102,350	$58,582	$0	0.57	23.10					
10	INSTALL REGENERATIVE BURNERS ON FURNACES	7.4.17	$544,901	$301,231	$3,728	0.55	39.33					
11	INSTALL FURNACE HEAT RECOVERY SYSTEM	7.4.20	$196,988	$163,784	$81,259	0.43	326.00					
12	MODIFY EXISTING WINDOWS	7.4.5	$165,396	$66,769	$0	0.40	32.75					
13	INSTALL HIGH-EFFICIENCY MOTORS ON ALL EQUIP.	7.4.14	$179,687	$39,599	$0	0.22	45.24					
14	INSTALL QUICK-OPENING DOORS AT ALL O.H. DOORS	7.4.8	$37,251	$10,639	$4,264	0.17	84.90					
15	INSTALL SEALS ON FURNACE DOORS	7.4.16	$53,888	$7,049	$0	0.13	162.44					
16	INSTALL STEAM COILS IN HYDRAULIC RESERVOIRS	7.4.12	$35,545	$11,982	$9,134	0.08	69.75					
17	INSULATE INSIDE OF EXTERIOR WALLS	7.4.7	$79,794	$588	$0	0.01	****					
18	CONTROL LIGHTS W/MOTION OR HEAT DETECTORS	--	--	--	--	--	--					
19	INSTALL GENERATOR SET TO REDUCE PEAK KW	7.4.13	--	--	--	--	--					
20	SCHEDULE JANITORIAL WORK DURING OPERATING HRS.	--	--	--	--	--	--					0
21	CLEAN & LUBRICATE MOTORS	--	--	--	--	--	--					0
22	SCHEDULE PRODUCTION TO MINIMIZE REHEATING	--	--	--	--	--	--					0
23	CHARGE ALL BATTERIES DURING OFF-PEAK HOURS	--	--	--	--	--	--					
24	INSTALL DP CONTROLS AT ALL FILTER BANKS	--	--	--	--	--	--					0
25	REPAIR HOSES ON COMPRESSED AIR SYSTEM	--	--	--	--	--	--					0

QRIP	PECIP OSD PIP	MCA	LOW COST NO COST	NO GOVT PROGRAM	NON-FEASIBLE	COMMENTS
0						
				0		Doesn't meet the criteria of any established government program.
0						
				0		Doesn't meet the criteria of any established government program.
				0		Doesn't meet the criteria of any established government program.
				0		Doesn't meet the criteria of any established government program.
					0	Simple payback exceeds 25 years.
				0		Doesn't meet the criteria of any established government program.
				0		Doesn't meet the criteria of any established government program.
					0	Simple payback exceeds 25 years.
					0	Simple payback exceeds 25 years.
					0	Simple payback exceeds 25 years.
					0	Simple payback exceeds 25 years.
					0	Simple payback exceeds 25 years.
					0	Simple payback exceeds 25 years.
					0	Simple payback exceeds 25 years.
					0	Simple payback exceeds 25 years.
					0	Unacceptable time-lag with MH and HPS light fixtures.
					0	No quantifiable energy savings.
			0			
			0			
			0			
					0	Prohibited by required cool-down period.
			0			
			0			

FIGURE 1.7

GOVERNMENT ENERGY CONSERVATION PROGRAMS



KEY:

ECIP PROJECT

NON-ECIP PROJECT

Note:

There is no established government program for energy conservation opportunities (ECO's) with construction costs under $200,000 and simple paybacks greater than 4 years but less than 25 years.

FIGURE 1.8

SUMMARY OF ENERGY CONSERVATION OPPORTUNITIES (ECOs)
BUILDING 222 - FORGE SHOP (CONT'D.)

ECO NO.	DESCRIPTION	DETAILED DESCRIP.	TOTAL INVESTMENT	DISCOUNTED SAVINGS	DISCOUNTED COSTS	SIR	SIMPLE PAYBACK	ECIP	QSIP	PECIP OSD PIP	MCA	LOW COST NO COST
26	KEEP O.H. DOORS CLOSED DURING HEATING SEASON	--	--	--	--	-	--					0
27	RESCHEDULE PRODUCTION TO OFF-PEAK HOURS	7.4.10	--	--	--	--	--					
28	CALIBRATE FURNACE CONTROLLERS & THERMOCOUPLES	--	--	--	--	--	--					0
29	INSTITUTE PREVENTATIVE MAINTENANCE PROGRAM	--	--	--	--	--	--					0
30	CONVERT ELECTRIC OVENS TO GAS-FIRED	--	--	--	--	--	--					
31	INSTALL POWER FACTOR CORRECTION EQUIPMENT	--	--	--	--	--	--					

Notes:

1. Given the current 20 percent utilization factor, the capital expenditure required to convert the existing electric ovens to gas-fired cannot be installed, gas-fired burners should be evaluated.

SIMPLE PAYBACK	ECIP	QMIP	PECIP OSD PIP	MCA	LOW COST NO COST	NO GOVT. PROGRAM	NON-FEASIBLE	COMMENTS
--					0			
--								No capital expenditure; possible increase in labor costs.
--					0			
--					0			
--							0	(See Note 1 below)
--							0	Automatically controlled capacitor banks already installed.

existing electric ovens to gas-fired cannot be economically justified. However, when existing units are replaced or new ovens

FIGURE 1.7 (CONT'D)

ROCK ISLAND ARSENAL

Energy Survey of Industrial Facilities

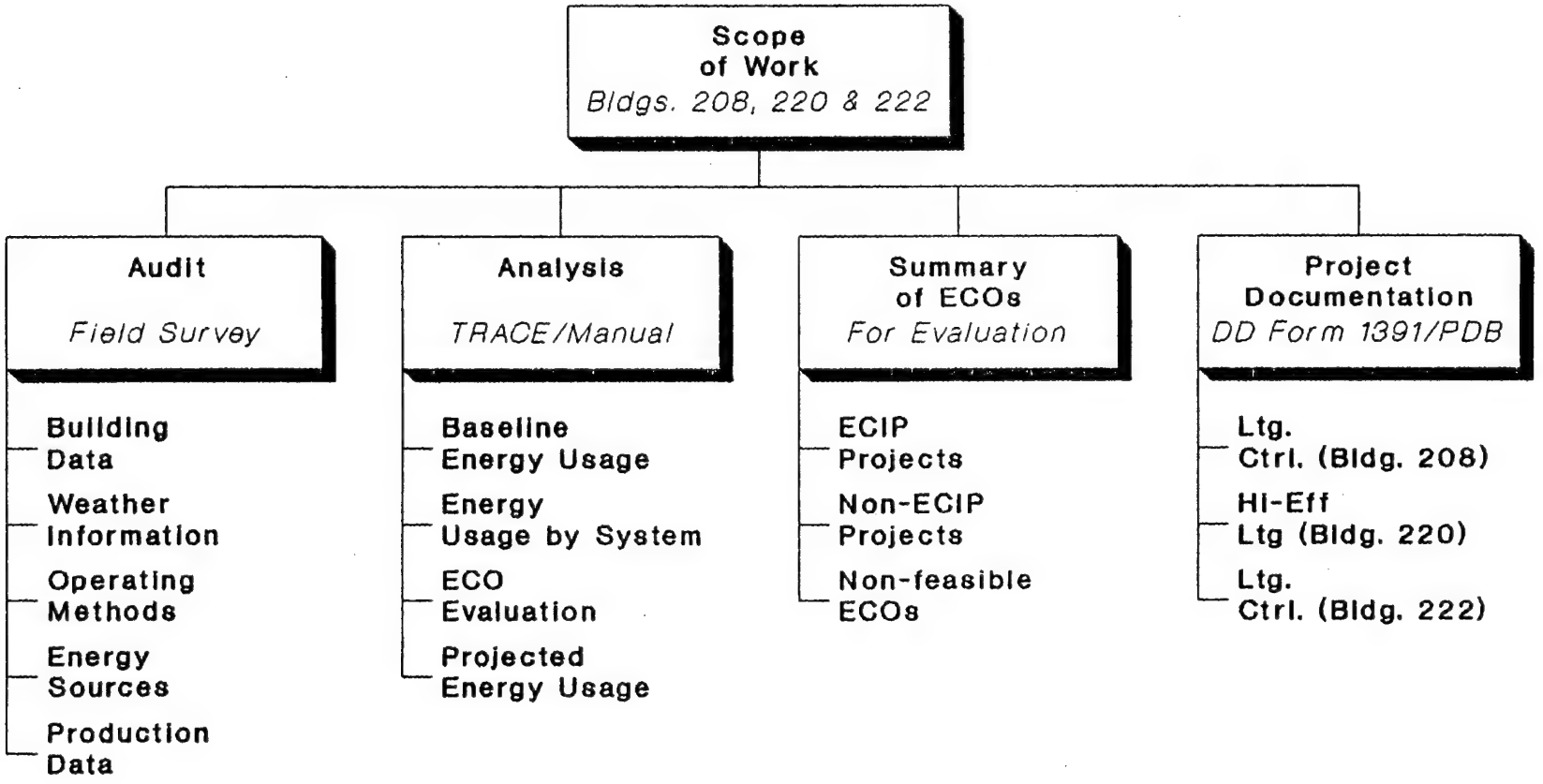


FIGURE 1.9

ROCK ISLAND ARSENAL

Prefinal Submittal Format

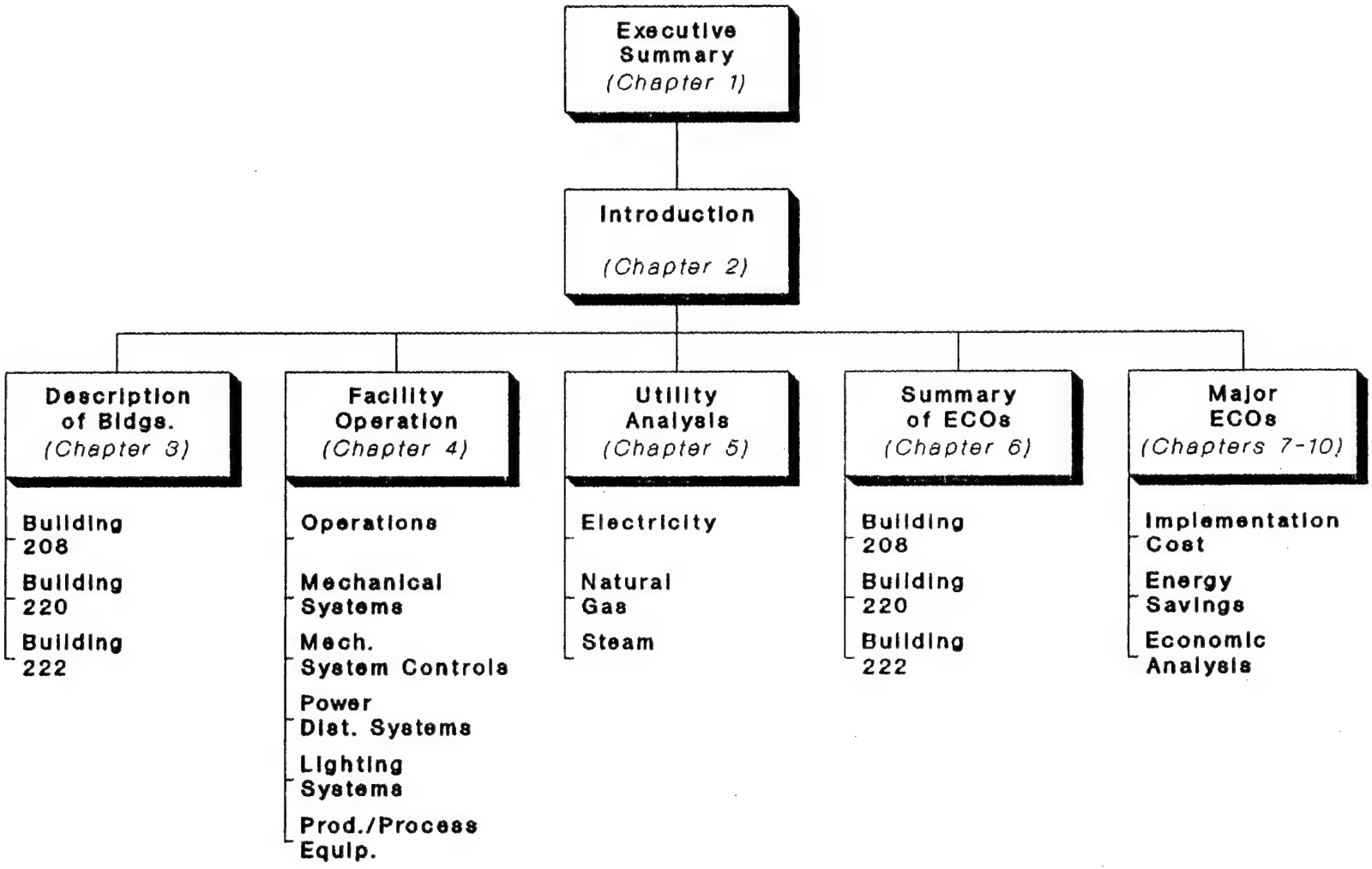


FIGURE 1.10

ROCK ISLAND ARSENAL

TRACE Flowchart

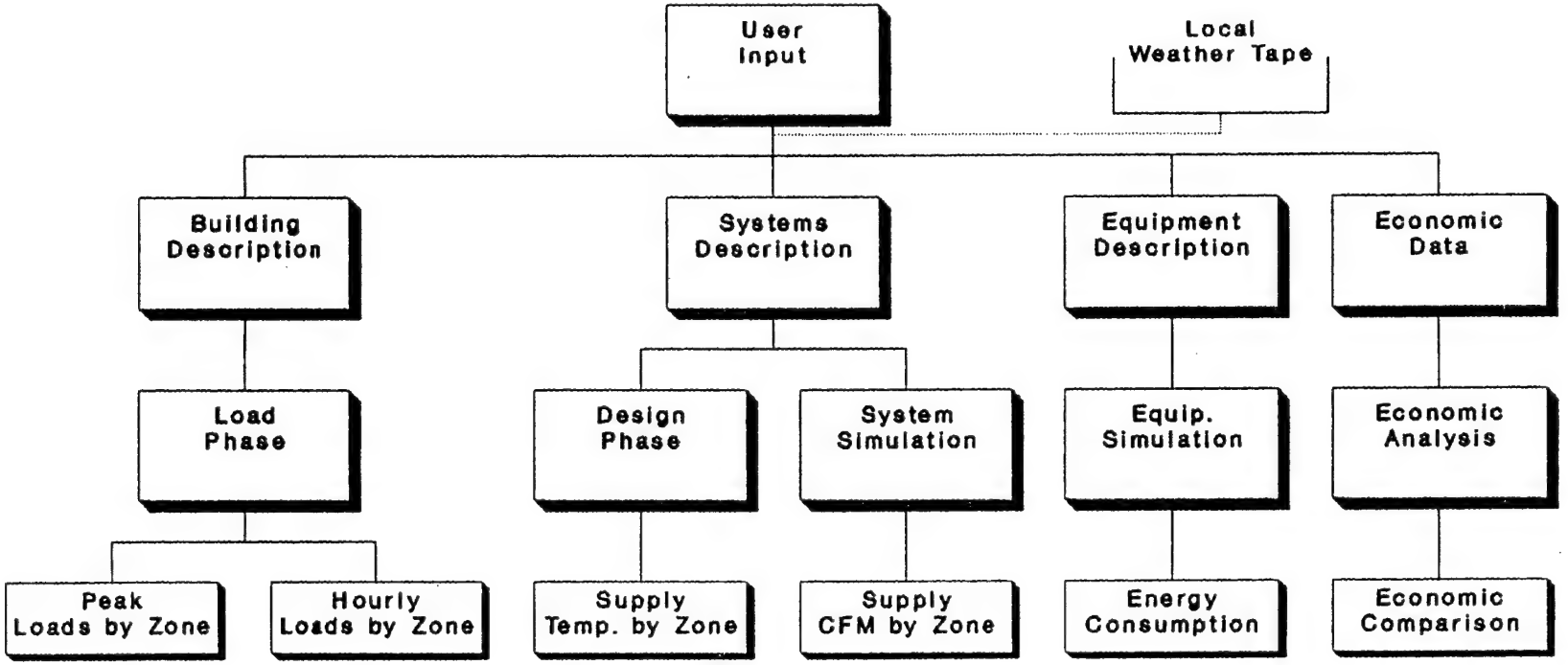


FIGURE 1.11

ROCK ISLAND ARSENAL

Energy Conservation Opportunities (ECOs)

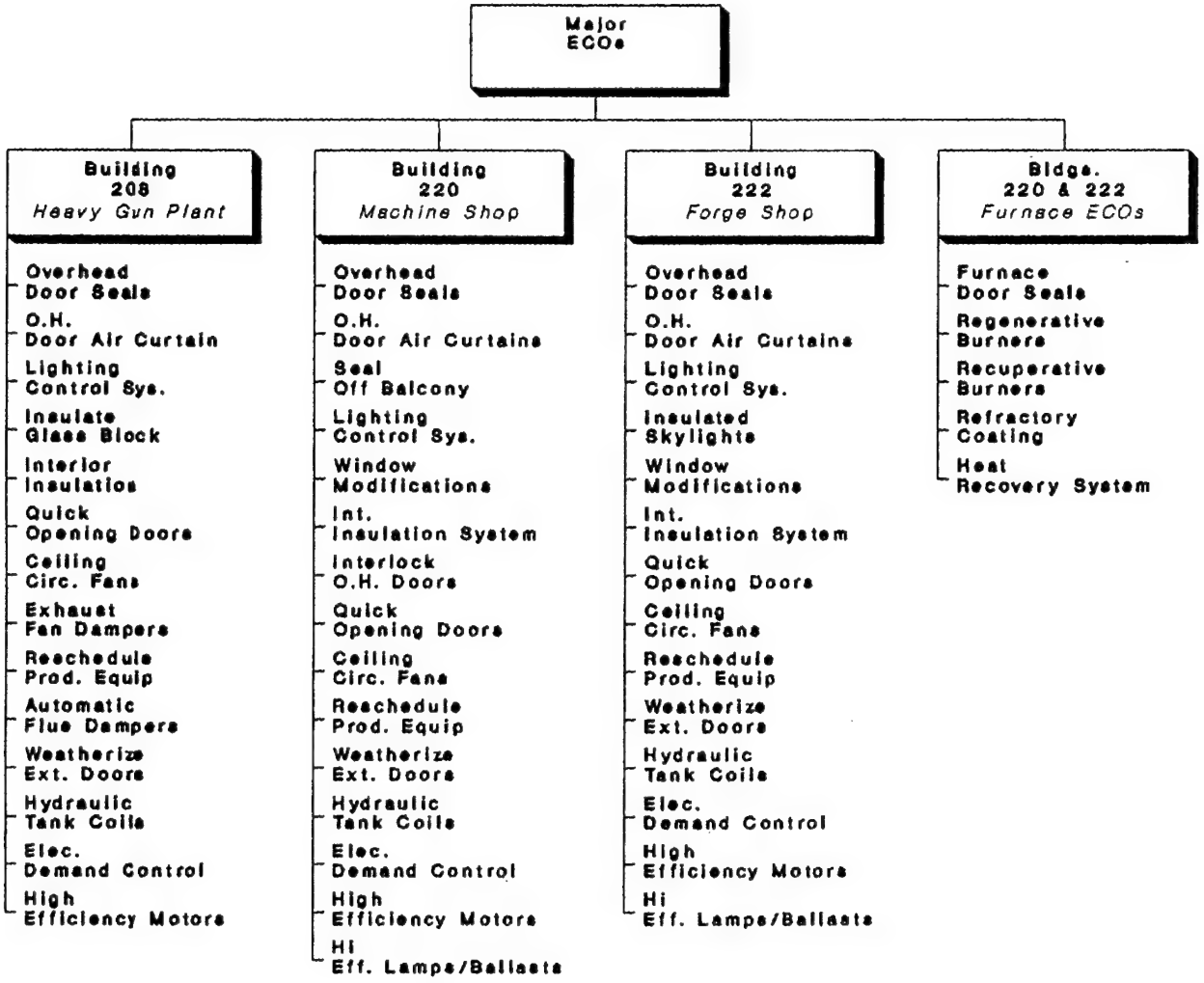


FIGURE 1.12

ROCK ISLAND ARSENAL

Energy Conservation Opportunities (ECOs)

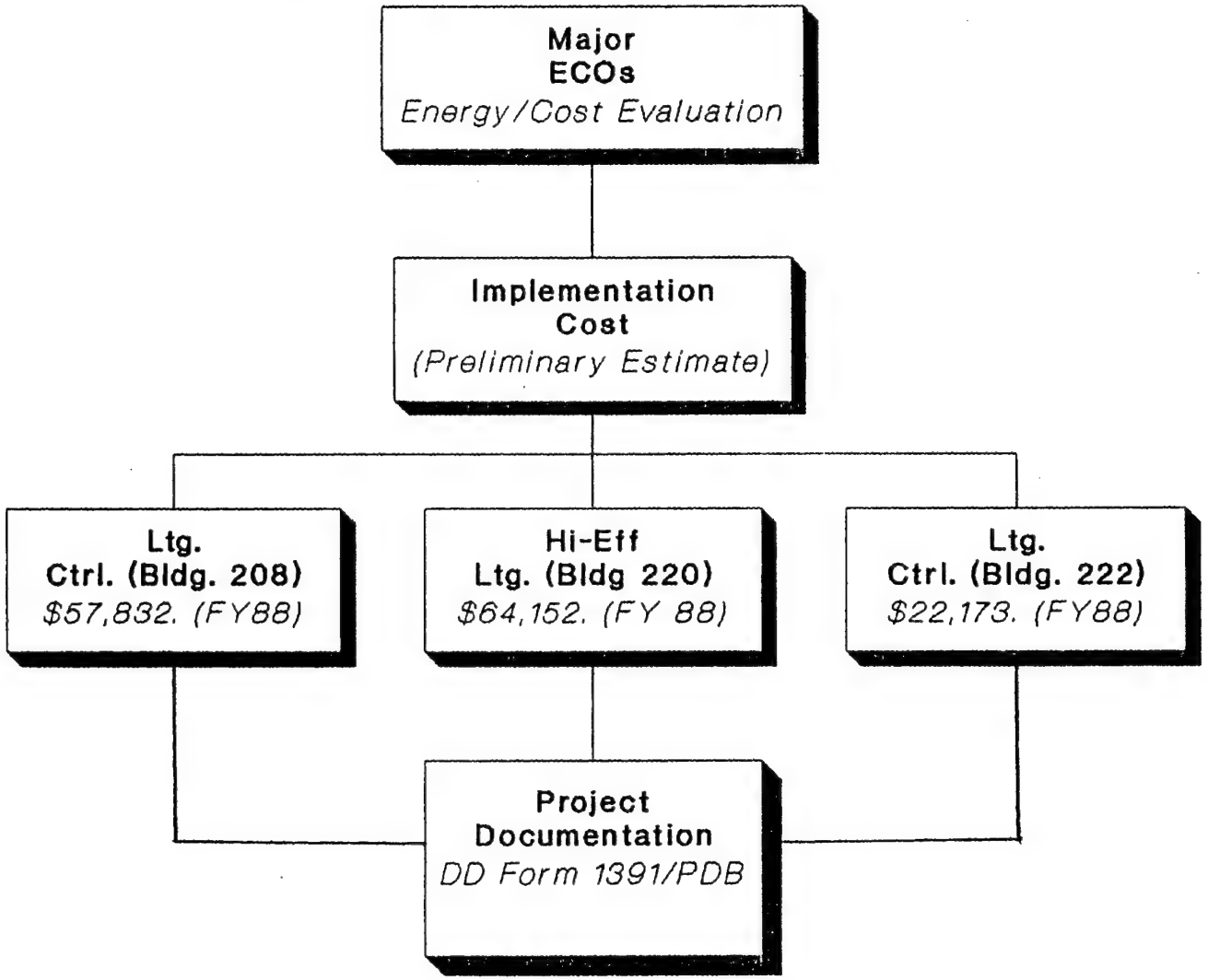


FIGURE 1.13

ROCK ISLAND ARSENAL

Energy Conservation Opportunities (ECOs)

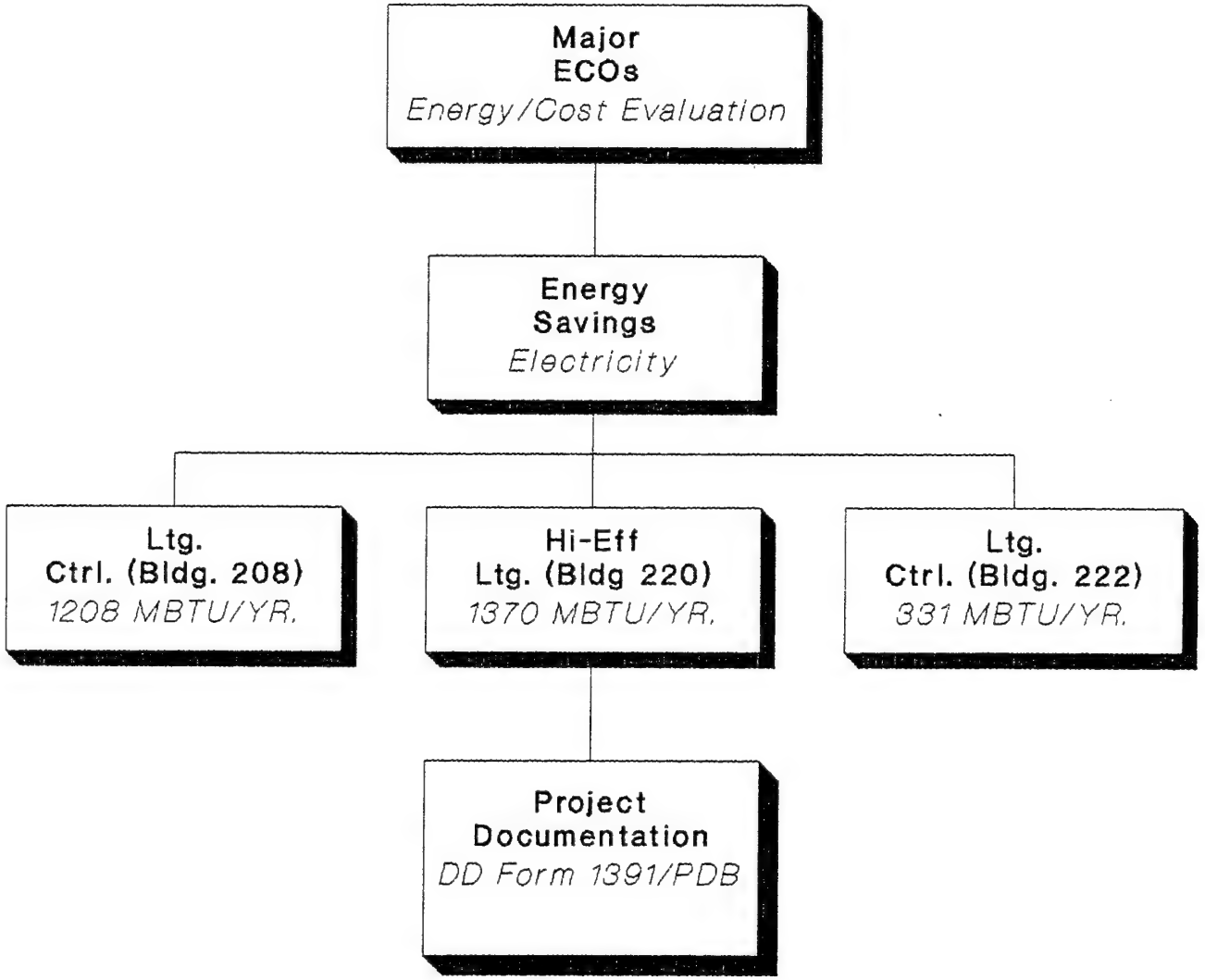


FIGURE 1.14

ROCK ISLAND ARSENAL

Energy Conservation Opportunities (ECOs)

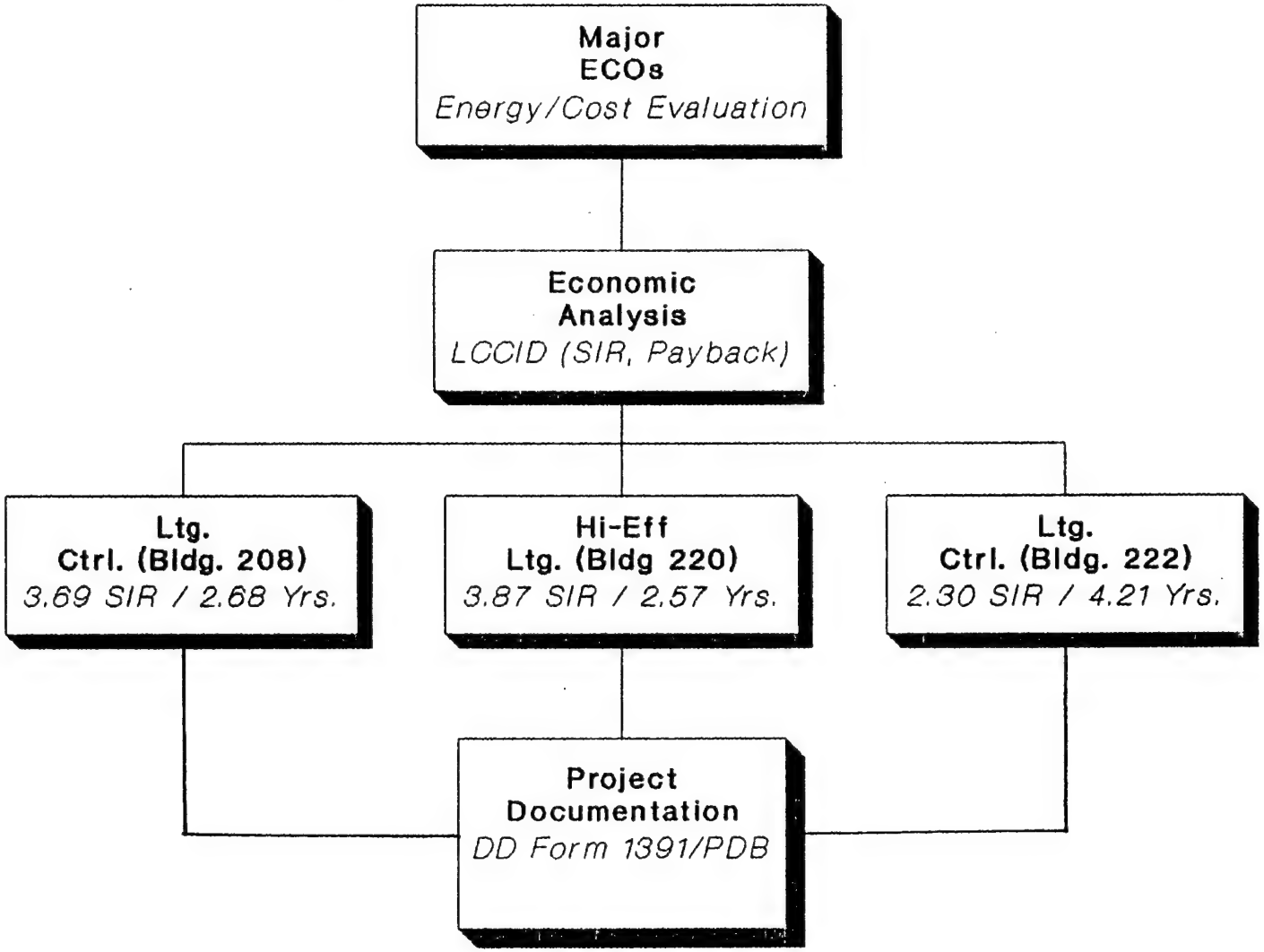
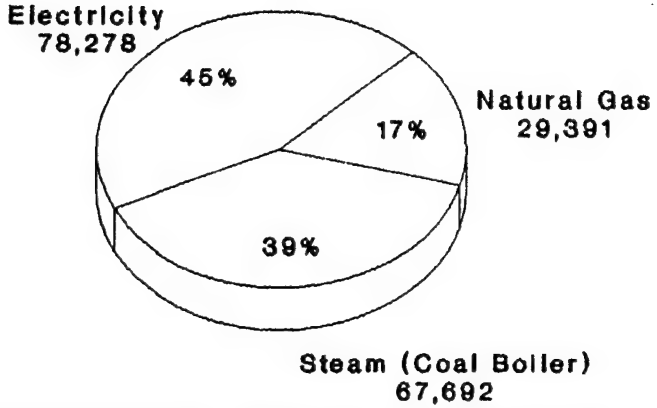


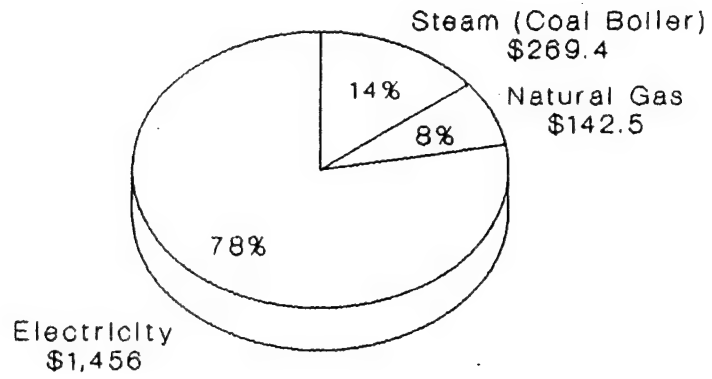
FIGURE 1.15

ROCK ISLAND ARSENAL

Bldgs. 208, 220 & 222



Annual Energy Usage by Fuel Source (MBTU)



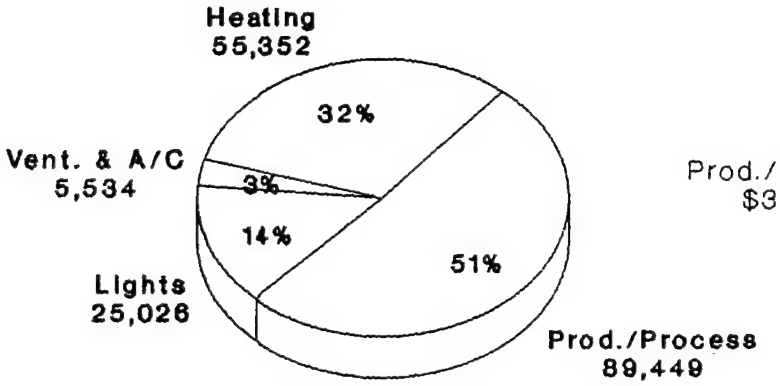
Annual Energy Usage by Fuel Source ($ 000/FY88)

Note: Usage computed using Governmemt furnished data and TRACE Energy Simulation Program (Refer to Appendix 11.5)

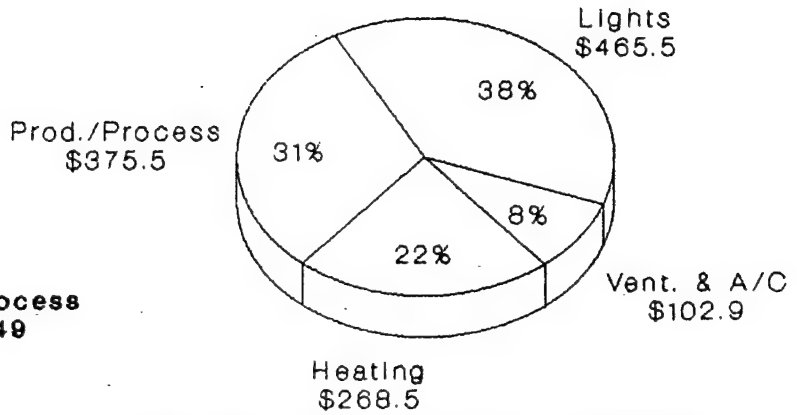
FIGURE 1.16

ROCK ISLAND ARSENAL

Bldgs. 208, 220 & 222



Annual Energy Usage by System (MBTU)



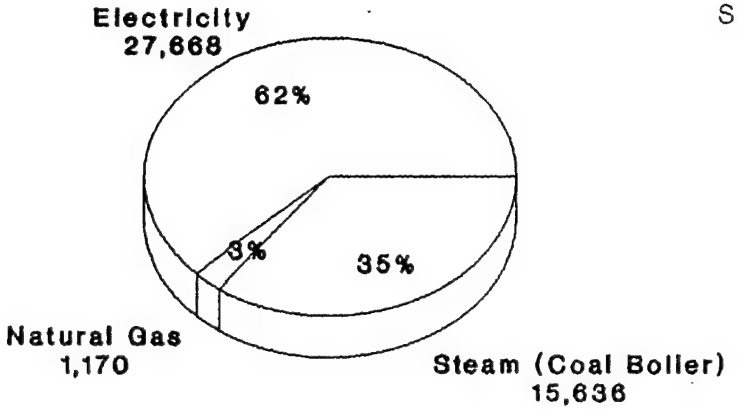
Annual Energy Usage by System ($ 000/FY88)

Note: Usage computed using Government furnished data and TRACE Energy Simulation Program (Refer to Appendix 11.5)

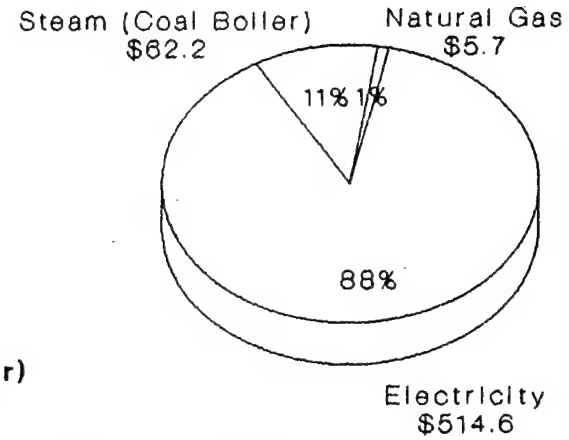
FIGURE 1.17

ROCK ISLAND ARSENAL

Bldg. 208 - Heavy Gun Plant



Annual Energy Usage by Fuel Type (MBTU)



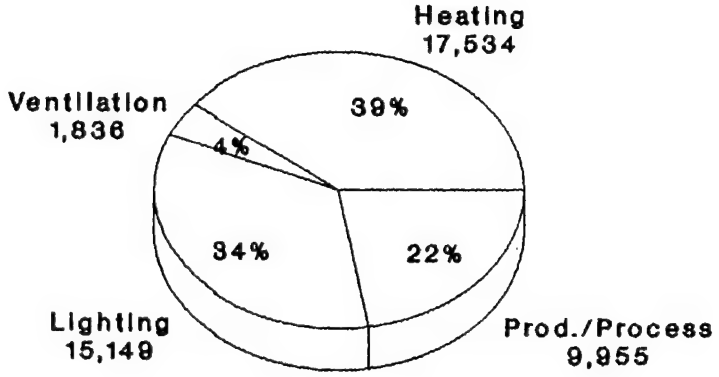
Annual Energy Usage by Fuel Type ($ 000/FY88)

Note: Usage computed using Government furnished data and TRACE Energy Simulation Program (Refer to Appendix 11.5)

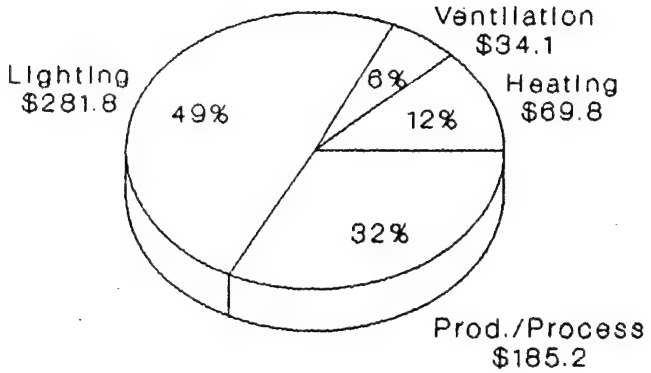
FIGURE 1.18

ROCK ISLAND ARSENAL

Bldg. 208 - Heavy Gun Plant



Annual Energy Usage by System
(MBTU)



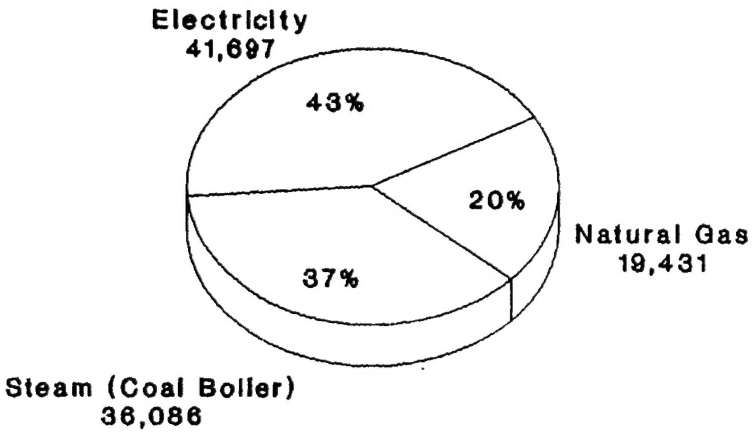
Annual Energy Usage by System
($ 000/FY88)

Note: Usage computed using Government furnished data and TRACE Energy Simulation Program (Refer to Appendix 11.5)

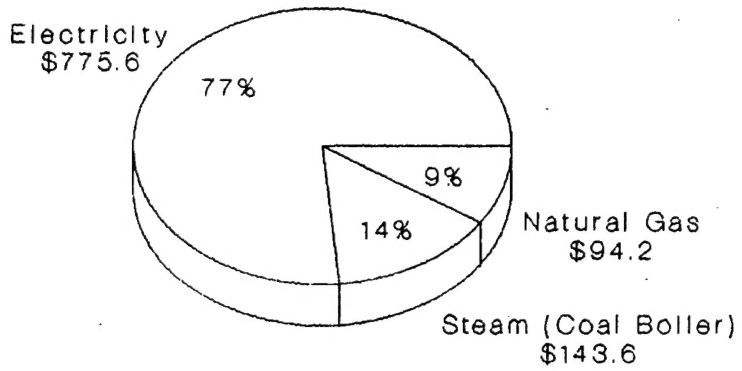
FIGURE 1.19

ROCK ISLAND ARSENAL

Building 220 - Machine Shop



Annual Energy Usage by Fuel Source (MBTU)



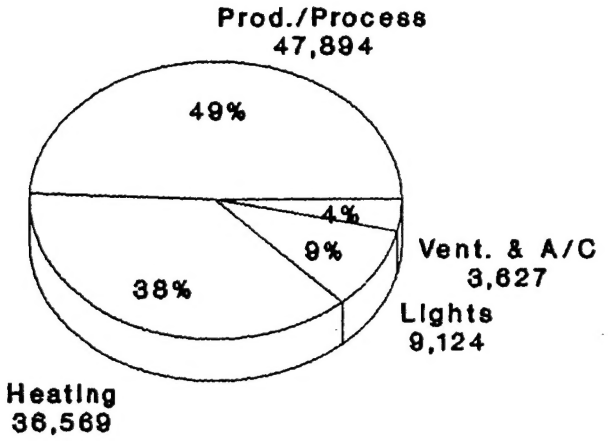
Annual Energy Usage by Fuel Source ($ 000/FY88)

Note: Usage computed using Government furnished data and TRACE Energy Simulation Program (Refer to Appendix 11.5)

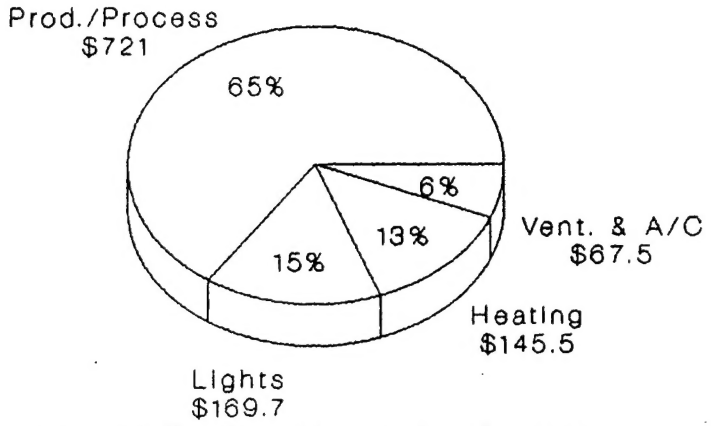
FIGURE 1.20

ROCK ISLAND ARSENAL

Building 220 - Machine Shop



Annual Energy Usage by System (MBTU)



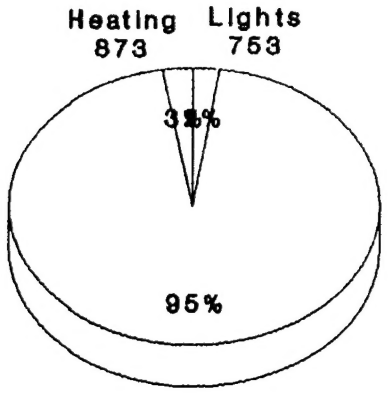
Annual Energy Usage by System ($ 000/FY88)

Note: Usage computed using Government furnished data and TRACE Energy Simulation Program (Refer to Appendix 11.5)

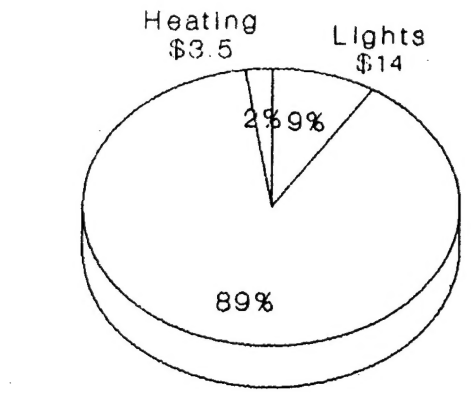
FIGURE 1.21

ROCK ISLAND ARSENAL

Building 222 - Forge Shop



Annual Energy Usage by System (MBTU)



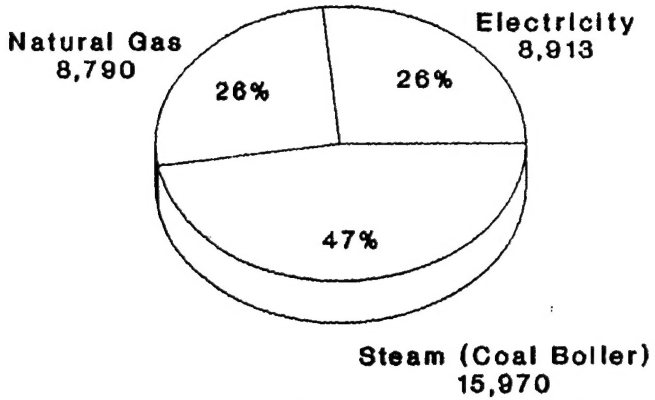
Annual Energy Usage by System ($ 000/FY88)

Note: Usage computed using Government furnished data and TRACE Energy Simulation Program (Refer to Appendix 11.5)

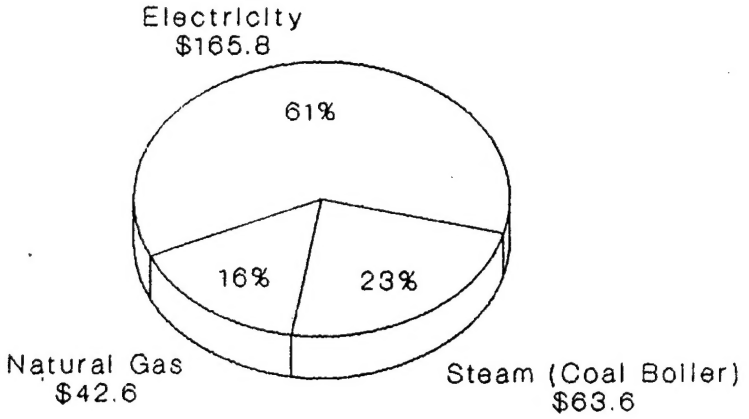
FIGURE 1.22

ROCK ISLAND ARSENAL

Building 222 - Forge Shop



Annual Energy Usage by Fuel Type (MBTU)



Annual Energy Usage by Fuel Type ($ 000/FY88)

Note: Usage computed using Government furnished data and TRACE Energy Simulation Program (Refer to Appendix 11.5)

FIGURE 1.23